

The International Sampling Program: Continent of Origin and Biological Characteristics of Atlantic Salmon Collected at West Greenland in 2013

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ABSTRACT

An Atlantic salmon (*Salmo salar*) mixed-stock fishery operating from 1 August through 31 October exists off the western coast of Greenland, which primarily harvests one-sea-winter (1SW) North American and European origin salmon destined to return to natal waters as two-sea-winter spawning adults. To collect data on the biological characteristics and origin of the harvest necessary for international stock assessment efforts, parties to the North Atlantic Salmon Conservation Organization's West Greenland Commission agreed to participate in an international sampling program for the 2013 fishery. The sampling program was coordinated by the US's NOAA Fisheries and involved 5 samplers from 5 countries deployed among 3 communities (Sisimiut, Maniitsoq, and Qaqortoq) located on the west coast of Greenland. Reported landings in 2013 were 47.0 metric tons (t). Data on length, weight, freshwater and marine age from scale samples, and continent of origin from genetic analysis of tissue samples were collected. Since 2002 (with the exception of 2006 and 2011), unreported landings were identified by comparing the reported landings to the weight of the sampled harvest for each community. Underreporting was detected in 2 of the 3 communities (Sisimiut and Qaqortoq) and the total adjusted landings for these communities were approximately 0.7 t higher than the reported landings. In total, 1286 salmon were observed by the sampling teams, and 1156 of these were sampled for biological characteristics, which represented ~9% by weight of the reported landings. As seen since the mid-1990s, a high proportion of the harvested stock was of North American origin (81.6%) with the balance being European origin (18.4%). North American origin fish were primarily freshwater age 2 or 3 years (32.6% and 37.3% respectively) and 1SW (94.9%). European origin fish were primarily freshwater age 2 (68.2%) and 1SW (96.6%). The mean lengths of North American and European 1SW salmon were 66.2 and 64.6 cm and the mean whole weights were 3.33 and 3.16 kg, respectively. Approximately 11,500 North American (38.9 t) and 2,700 European salmon (8.8 t) were harvested, not taking into account any unreported catch. The sampling program was successful in adequately sampling the Greenland catch, both temporally and spatially, and provided essential input data to international stock assessment efforts, which provide stock status and catch options for subsequent fishery management.

INTRODUCTION

An important mixed-stock Atlantic salmon (*Salmo salar*) fishery exists off the western coast of Greenland. This fishery takes primarily one-sea-winter (1SW) North American and European origin salmon that would potentially return to natal waters as mature two-sea-winter (2SW) spawning adults or older. Effective management of the resource on both continents requires annual collection of accurate landings data, continent of origin assignments, and biological characteristics data to assess the impact of the fishery on the contributing stock complexes. Data collected during the fishery are also required for use in assessment models to predict pre-fishery abundance of North American and European stocks to provide fishery managers with catch options required for setting harvest regulations.

Atlantic salmon were first documented off the coast of Greenland in 1780 and were targeted by a small local inshore gillnet fishery (Jensen 1990). During the early 1960s, the fishery developed an international presence; in 1965, vessels from Norway, Denmark, Sweden, and the Faroe Islands arrived and introduced an offshore drift-gillnet fishery (Jensen 1990). Reported catches increased to a high of 2689 metric tons (t) in 1971 (Figure 1). Mark-recapture studies conducted during this period indicated that the Atlantic salmon caught in this fishery were of North American and European origin or were not uniformly distributed along the coast (Reddin et al. 2012). Because of concerns that this fishery would have deleterious impacts on the contributing stock complexes, a quota system was agreed upon and implemented in 1976 (Colligan et al. 2008), and, since 1984, catch regulations have been established by the North Atlantic Salmon Conservation Organization (NASCO).

Since 1969, a coordinated international sampling program has been conducted to obtain biological samples from the Greenland salmon fishery. From 1969-1981, research vessels were used to obtain samples. Since 1982, international teams of samplers have been deployed throughout West Greenland to obtain samples from fish processing plants (when a commercial fishery was allowed), local markets, and other vendors from individual communities where Atlantic salmon are being landed. The purpose of this sampling program was to collect biological data and samples. Historically, length, weight, and scale samples were collected and individual salmon were scanned for fin clips or external/internal tags. Beginning in 2002, tissue samples have been collected from fish for genetic stock identification.

The purpose of this paper is to:

- describe the international sampling program;
- present the results from the continent of origin analysis; and
- summarize the biological characteristics of the catch from West Greenland during the internal-use-only fishery of 2013.

International Sampling Program

The West Greenland Commission (WGC) of the NASCO has agreed on regulatory measures for the West Greenland fishery for all years from 1984 onward (with the exception of 1985, 1991, 1992, and 1996). Since 2006, these have been applied as multi-year regulatory measures. The latest measure was established for the period 2012-2014 (WGC(12)12) and restricted landings in 2012 to the amount used for internal consumption in Greenland only, which in the past has been estimated to be 20 t. In addition, no commercial export of salmon is allowed. These regulatory measures were also to be applied in 2013 and 2014 if the Framework of Indicators (FWI) developed and updated by the International Council for the Exploration of the Sea (ICES 2007, 2012) indicated no significant change, implying that a reassessment of the catch advice would not be required (WGC(12)12). The FWI was applied in 2013 and the result indicated that a reassessment of the catch advice was not required for 2013. Therefore, 2012 regulatory measures should continue for the 2013 fishery. The FWI will again be applied in 2014 to determine if the 2012 regulatory measures will continue for the 2014 fishery.

In 2002, the Organization of Fishermen and Hunters in Greenland (KNAPK) agreed with the North Atlantic Salmon Fund (NASF) to be compensated for not prosecuting a commercial fishery. As part of this agreement, an annual opt-out date was established whereby either party could notify the other that the agreement would not be implemented for the upcoming fishing season. In 2007, a new agreement between KNAPK, NASF, and the Atlantic Salmon Federation was signed that effectively extended and revised the 2002 agreement through 2013, retaining the same opt-out option and date as the 2002 agreement.

From 2002-2011 the quota for commercial landings of Atlantic salmon for export was set to 0 tons by the Government of Greenland, but the internal-use-only fishery for personal and local consumption was unaffected. Licensed fishermen were permitted to sell salmon to hotels, institutions, and local markets. Also, licensed fishers and unlicensed fishers were allowed to land salmon for private consumption. The internal-use-only fishery was without a quota limit, but in the past has been estimated at 20 t annually. The fishery generally operates during the months of August, September, and October and since 2005 the fishery has opened on 1 August and closed on 31 October. The fishery is regulated according to the Government of Greenland Executive Order No. 12 of August 1, 2012 (an update of the previous order, Government of Greenland Executive Order No. 21 of 10 August 2002).

In 2012, the Government of Greenland again set the national quota for commercial landings of Atlantic salmon for export to 0 tons. No export of salmon from Greenland was allowed. However, the Government of Greenland set a 35 t national quota for landing at fish processing factories to provide a year-round supply of locally harvested Atlantic salmon within Greenland. The internal-use-only fishery for personal and local consumption remained unaffected and unrestricted by the quota for factory landings.

Under NASCO's West Greenland Sampling Agreement (WGC(13)5), parties to NASCO's WGC agreed to provide staff to sample Atlantic salmon catches from the West Greenland internal-use-only fishery during the 2013 season.

The objectives of the sampling program were to:

- continue the time series of data (1969-2012) on continent of origin and biological characteristics of the Atlantic salmon in the West Greenland fishery;
- provide data on mean weight, length, age, and continent of origin for use in the North American and European Atlantic salmon run-reconstruction models; and
- collect information on the recovery of internal and external tags.

As outlined in the sampling agreement, the European Union agreed to provide staff to sample the fishery for a minimum of 6 person-weeks; the US agreed for a minimum of 2 person-weeks; and Canada agreed for a minimum of 2 person-weeks. Samplers from various countries involved in the program were as follows:

Country	Sampler(s)	Institute	Period	Community (NAFO Division)
UK (Scotland)	Simon McKelvey	Cromarty Firth Fishery Trust	28 Aug – 11 Sep	Qaqortoq (1F)
UK (England & Wales)	Simon Toms	Environment Agency	31 Aug – 15 Sep	Maniitsoq (1C)
Canada	Denise Deschamps	Ministère des forêts, de la faune et des parcs	10 Sep – 29 Sep	Sisimiut (1B)
USA	Tara Trinko Lake	NOAA Fisheries Service	24 Sep – 08 Oct	Qaqortoq (1F)
Ireland	Katie Thomas	Marine Institute	28 Sep – 13 Oct	Maniitsoq (1C)

Individual samplers were deployed during the course of the fishing season to provide the best possible spatial and temporal coverage of the fishery, given logistic and other considerations. The coordination of this effort was handled by the US's NOAA Fisheries, with assistance from the Greenland Institute of Natural Resources (GINR). Samplers were stationed in 3 communities representing 3 Northwest Atlantic Fisheries Organization (NAFO) divisions (Figure 2): Sisimiut (1B), Maniitsoq (1C) and Qaqortoq (1F). Samplers were not deployed to Nuuk (1D) because of continued uncertainty of access to landed Atlantic salmon in this community (ICES 2012).

Reported landings in 2013 were 47.0 t (46.9 t for West Greenland and <0.03 t for East Greenland ICES Statistical Area XIV). In the past, non-reporting of harvest was identified by comparing the reported landings to the sample data. From 2002-2012 (with the exception of 2006 and 2011), the sampling team documented more fish than reported in at least one division (ICES 2013). A documented salmon could be one that was either sampled, checked for an adipose clip only, or not sampled but seen. When this type of discrepancy occurs, the reported landings are adjusted to include the total weight of the fish documented as being landed during the sampling period and the adjusted landings are included in all subsequent assessments. In 2013, discrepancies occurred in 2 of the 3 sampled communities (Table 1). Reported landings for Sisimiut were 2356 kg and the adjusted landings were determined to be 2458 kg (difference of only 102 kg, 4% of reported landings); in Qaqortoq the reported landings were 133 kg and were adjusted to be 767 kg (difference of 634 kg, 477% of reported landings). The reported landings and adjusted landings for 2002-2013 are presented in Table 2. To provide the most reliable estimate of catch and therefore the potential fishery impacts on contributing stocks, it is important to continue to improve the catch reporting procedure and the quality of the catch statistics.

Landed fish were sampled at random and, when possible, the total catch was sampled. Individual fish were measured (fork length, mm) and weighed (gutted weight or whole weight, kg). Scales were taken for age determination, and adipose fins were taken for DNA analysis for stock identification. Fish were also examined for fin clips, external marks, external tags, and internal tags. Adipose-clipped fish were sampled for microtags (coded wire tags).

A total of 1286 salmon were observed by the sampling teams. Of these, 1156 were sampled for biological characteristics (representing ~9% by weight of the reported landings), 90 were only checked for an adipose clip, and 40 were documented as being landed but were not sampled or examined further. Biological characteristics data were collected as follows:

- 1155 fork lengths;
- 1131 gutted weights;
- 48 whole weights;
- 1156 scale samples;
- 1149 genetic samples; and
- 26 sex identifications from gonadal examination.

A total of 13 adipose-clipped fish were documented. Of all the fish examined by the samplers, none had an external or an internal tag. A single tag was submitted to the GINR by local fisherman from unsampled fish (reported harvested in 2013). The tag breakdown was as follows (Table 3):

- 1 Carlin/streamer/spaghetti tag

Sampling often takes place at a local market, as that is a centralized location where harvested salmon are present and available. Prior to any sampling, the sampler always obtained permission from the market manager. This arrangement has generally been successful for all samplers, although there have been issues in some years in Nuuk (Sheehan et al. 2013). Because of concerns that proper arrangements had not been made to allow sampling of fish in Nuuk in 2012, no samples were collected from Nuuk.

Landings were allowed to factories in 2013 and only 4 factories received salmon. Information about which factories intended to receive salmon in 2013 was not available prior to the organizing the sampling program; therefore, no samplers were deployed to communities where factories were landing salmon. As a result, no samples were collected from factories in 2013. The lack of samples from factory landings could potentially bias the estimated biological characteristics and continent of origin estimates of the harvested population. However, the sampling program obtained samples from one division where factory landings occurred as well as from divisions to the north and south of the remaining factories.

The limitation of the fishery to internal-use-only caused some practical problems for the sampling teams; however, the sampling program provided adequate representation of the Greenland catch, both temporally and spatially. Considering that no samples were obtained from Nuuk, where a significant proportion of the annual landings occur or from the factories where Atlantic salmon were landed in large number, the potential for bias exists when describing the biological characteristics of the harvest, stock assessment results, and catch advice. However, any potential bias is expected to be minimized given that sampling occurred both to the north and to the south of Nuuk.

CONTINENT OF ORIGIN

Fin tissue samples were collected and preserved in RNeasyTM,¹ an aqueous, non-toxic tissue and cell storage reagent that stabilizes and protects cellular RNA. A total of 1149 usable samples were collected from 3 communities in 3 NAFO divisions: Sisimiut in 1B (n=680), Maniitsoq in 1C (n=298), and Qaqortoq in 1F (n=171). A small number of tissue samples (n<10) were collected, but were not processed due to poor sample quality and therefore removed from the database.

DNA isolation and the subsequent microsatellite analyses were performed according to standardized protocols (King et al. 2001; Sheehan et al. 2010). A database of approximately 5000 Atlantic salmon genotypes of known origin was used as a baseline to assign the samples to continent of origin. In total, 81.6% of the salmon sampled were of North American origin and

¹ Reference to trade names does not imply endorsement by any collaborating agency or government.

18.4% were of European origin. The NAFO division-specific continent of origin assignments are presented in Table 4.

These findings show that high proportions of fish from the North American stock complex continue to contribute to the fishery (Figure 3). The variability in the recent stock complex contributions between divisions and the deviation from past trends (Figure 4) underscore the need to annually sample multiple NAFO divisions to achieve accurate estimates of continental contributions to the harvest.

Variations in the estimated weighted proportions of North American and European salmon in the fishery during 1987-2012 are shown in Table 5 and Figure 4. The 2013 North American weighted contribution (82%) to the fishery was above the long-term mean (1982-2013, 68%), but approximately equal to the recent 10-yr mean (2004-2013, 80%). The European weighted contribution (18%) to the 2013 fishery was below the long-term mean (1982-2013, 32%), but approximately equal to the 10-yr mean (2004-2013, 20%). In terms of numbers of fish, the 2013 fishery caught approximately 11,500 North American salmon (38.9 t) and 2700 European fish (8.8 t; Table 5 and Figure 5). The 2013 total number of fish harvested (14,200) is higher than in 2012 (9900) and above the 10-yr mean (2004-2013; 8580 fish). It is the 15th highest total in the 30-yr time series (1982-2013, with no harvest estimates in 1993 and 1994), but only 4.2% of the maximum estimate of 336,000 fish harvested in 1982.

BIOLOGICAL CHARACTERISTICS OF THE CATCHES

Biological characteristics (length, weight, and age) were recorded for all sampled fish. Overall across all sea ages, the mean sampled fork length was 66.2 cm and the mean gutted weight was 3.02 kg.

An overall decrease in mean whole weight of both European and North American 1SW salmon occurred between 1969 and 1995 (Table 6 and Figure 6). This trend was reversed in 1996 when mean weights began to increase, although evidence suggests that these trends may be partially explained by annual variation in the timing of the sampling program (ICES 2011). In 2013, the mean length of North American 1SW salmon was 66.2 cm and the mean whole weight was 3.33 kg; the mean length of European 1SW salmon was 64.6 cm and the mean whole weight was 3.16 kg. The North American 1SW fork length estimate increased slightly from 2012 (65.4 cm) and was slightly above the 10-yr mean (65.3 cm). The European 1SW mean fork length was approximately equal to the 2012 (64.9 cm) and 10-yr mean (64.9 cm) estimates. The North American 1SW whole weight was approximately the same as the 2012 value (3.34 kg) and was higher than the recent (2004-2013) 10-yr average (3.20 kg). The European 1SW whole weight was lower than the 2012 value (3.38 kg) and was approximately equal to the recent (2004-2013) 10-yr average (3.18 kg). A summary of the mean fork lengths and whole weights in the 2013 fishery by sea age, continent of origin, and NAFO division is presented in Table 7. Note that the weight data have not been adjusted for date of capture so may not represent an actual change in

mean weight over the time series, because fish sampled later in the fishing season have had additional time to grow compared to fish sampled early in the season (ICES 2011).

The smolt age distribution of the total catch by continent of origin is presented in Table 8. The smolt age distributions by origin for all North American and European origin salmon caught (1968-2013) are provided in Table 9.

In 2013, the percentages of fish by smolt age within continent of origin were:

Continent of origin	Percent of continent of origin by smolt age (years)					
	1	2	3	4	5	6
North American	0.1%	32.6%	37.3%	20.8%	8.6%	0.6%
European	4.5%	68.2%	24.4%	2.5%	0.5%	0%

The mean smolt age of the 2013 North American origin samples was 3.1 yr. Although age-1 smolts historically represent a small proportion of the catch (10-yr mean of 1.3%), the 2013 value (0.1%) is one of the lowest. This is indicative of the relatively minor contribution of the more southerly North American populations to the fishery. The percentage of smolt age-2 salmon of North American origin in the 2013 fishery (32.6%) is higher than in 2012 (29.8%) and higher than the 10-yr mean (25.8%). Age-3 and older smolts accounted for 67.3% of the 2013 harvest of North American fish, which is below the 10-yr mean (72.9%).

The mean smolt age of the European salmon in 2012 was 2.3 yr. The percentage of smolt age 1 (4.5%) is lower than in 2012 (9.3%) and also below the 10-yr mean of 12.8%. The percentage of age-2 smolts (68.2%) in the 2013 fishery is higher than in 2012 (63.0%) and also above the 10-yr mean (59.3%). The contribution of age-3 and older European origin smolts (27.4%) is approximately equal to the 10-yr mean (27.9%).

As expected, the 1SW age group was dominant (95.2%) in the 2013 fishery (Table 10). This value is slightly above the 2012 value (94.1%). Concerns have been raised over recent difficulty with discerning winter annuli from apparent ‘checks’ in the marine zone of Atlantic salmon multi-sea winter scales. Care should be taken to properly discern true marine annuli from growth checks; further study of this phenomenon is warranted.

In 2013, the proportions by sea age by continent of origin were:

Continent of origin	Percent of continent of origin by sea age (years)			
	1SW	2SW	3SW	Repeat Spawners
North American	94.9%	1.4%	0%	3.7%
European	96.6%	2.4%	0%	1.0%

As part of the sampling, sex was determined by examination of the gonads of 26 fish. Of these samples, 6 (23%) were male and 20 (77%) were female.

A total of 29 salmon microbiomes (bacterial communities in the gut and skin) samples were collected from salmon landed in 2 different communities (Sisimiut and Maniitsoq). The purposes of this research is to genetically characterize the microbiomes population composition and look at the role of salmon skin and gut bacterial communities, in particular how they provide common 'services' such as nutrient absorption and in immune response. The samples are for a researcher based jointly at the University of Laval in Quebec and Bangor University in Wales.

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Table 1. Evaluation of underreporting in sampled communities during the 2013 Greenland Atlantic salmon (*Salmo salar*) fishery by community/Northwest Atlantic Fisheries Organization (NAFO) division. The total number of salmon documented by the sampling teams (salmon that have been sampled, seen but not sampled, and seen and checked for an adipose fin clip only) is converted to a total whole weight and compared to the reported landings (commercial and private sectors only) for each community.

Community (NAFO Division)	Number sampled	Additional Number seen	Average sampled gutted wt (kg)	Average converted whole wt (kg)		
Sisimiut (1B)	682	64	2.97	3.30		
Maniitsoq (1C)	302	15	3.09	3.43		
Qaqortoq (1F)	172	51	3.10	3.44		
Total	1156	130	3.02	3.35		

Community	Estimated whole wt sampled/seen (kg)	Reported landings (kg)	Adjusted Landings (kg)	Difference (kg)	Difference as % of reported landings
Sisimiut (1B)	2,458	2,356	2,458	102	4%
Maniitsoq (1C)	1,087	3,719	3,719	0	0%
Qaqortoq (1F)	767	133	767	634	477%
Total	4312	6208	6944	736	12%

Table 2. Total reported landings (kg) for the Greenland Atlantic salmon (*Salmo salar*) fishery (2002–2013) by Northwest Atlantic Fisheries Organization (NAFO) division as reported by the Home Rule Government and the division-specific adjusted landings where the sampling teams observed more fish landed than were reported. Landings from International Council for the Exploration of the Sea Statistical Area XIV (East Greenland) are not included in the assessment, but amounted to 0 t in 2013. Shaded cells indicate that sampling took place in that year and division.

		NAFO Division						Total
Year		1A	1B	1C	1D	1E	1F	
2002	Reported	14	78	2,100	3,752	1,417	1,661	9,022
	Adjusted						2,408	9,769
2003	Reported	619	17	1,621	648	1,274	4,516	8,694
	Adjusted			1,782	2,709		5,912	12,312
2004	Reported	3,476	611	3,516	2,433	2,609	2,068	14,712
	Adjusted				4,929			17,209
2005	Reported	1,294	3,120	2,240	756	2,937	4,956	15,303
	Adjusted				2,730			17,276
2006	Reported	5,427	2,611	3,424	4,731	2,636	4,192	23,021
	Adjusted							
2007	Reported	2,019	5,089	6,148	4,470	4,828	2,093	24,647
	Adjusted						2,252	24,806
2008	Reported	4,882	2,210	10,024	1,595	2,457	4,979	26,147
	Adjusted				3,577		5,478	28,627
2009	Reported	195	6,151	7,090	2,988	4,296	4,777	25,496
	Adjusted				5,466			27,975
2010	Reported	17,263	4,558	2,363	2,747	6,766	4,252	37,949
	Adjusted		4,824		6,566		5,274	43,056
2011	Reported	1,858	3,662	5,274	7,977	4,021	4,613	27,407
	Adjusted							
2012	Reported	5,353	784	14,991	4,564	3,993	2,951	32,636
	Adjusted		2,001				3,694	34,596
2013	Reported	3,052	2,359	17,950	13,356	6,442	3,774	46,933
	Adjusted		2,461				4,408	47,669

Table 3. Reported tag recaptures from the 2013 Greenland Atlantic salmon (*Salmo salar*) fishery.

tag information		Release information				Recapture information			
Tag type	Tag code (Seq. code)	Country	River released	Release Date	Life stage	Community	Recapture year	Recapture Date	Recapture length (cm)
carlin	NL 083810 (green)	Norway	Imsa	15-May-12	smolt	Maniitsoq (1C)	2013		75

Table 4. The continental proportions of North American (NA) and European (E) Atlantic salmon (*Salmo salar*) caught in West Greenland 2013 by Northwest Atlantic Fisheries Organization (NAFO) division.

NAFO Div.	Fishing dates	NA	Number E	Totals	Percentages NA	E
1B	Sep 09 - Sep 29	567	113	680	83.4	16.6
1C	Sep 08 - Oct 11	245	53	298	82.2	17.8
1F	Aug 28 - Oct 07	126	45	171	73.7	26.3
TOTAL		938	211	1149	81.6	18.4

Table 5. The catch-weighted numbers of North American (NA) and European (E) Atlantic salmon (*Salmo salar*) caught at West Greenland 1971-2013 and the proportion of the catch by weight. Numbers are rounded to the nearest hundred fish. Continent of origin assignments were based on scale characteristics until 1995, scale characteristics and DNA-based assignments until 2001, and DNA-based assignments only from 2002 onwards.

	Proportion weighted by catch		Numbers of Salmon caught	
	NA	E	NA	E
1982	57	43	192,200	143,800
1983	40	60	39,500	60,500
1984	54	46	48,800	41,200
1985	47	53	143,500	161,500
1986	59	41	188,300	131,900
1987	59	41	171,900	126,400
1988	43	57	125,500	168,800
1989	55	45	65,000	52,700
1990	74	26	62,400	21,700
1991	63	37	111,700	65,400
1992	45	55	46,900	38,500
1993	-	-	-	-
1994	-	-	-	-
1995	67	33	21,400	10,700
1996	70	30	22,400	9,700
1997	85	15	18,000	3,300
1998	79	21	3,100	900
1999	91	9	5,700	600
2000	65	35	5,100	2,700
2001	67	33	9,400	4,700
2002	69	31	2,300	1,000
2003	64	36	2,600	1,400

Table 5. Continued.

	Proportion weighted by catch		Numbers of Salmon caught	
	NA	E	NA	E
2004	72	28	3,900	1,500
2005	74	26	3,500	1,200
2006	69	31	4,000	1,800
2007	76	24	6,100	1,900
2008	86	14	8,000	1,300
2009	89	11	7,000	800
2010	80	20	10,000	2,600
2011	93	7	7,500	600
2012	79	21	7,800	2,100
2013	82	18	11,500	2,700

Table 6. Annual mean fork lengths and whole weights by continent of origin (NA - North American and E – European) and sea age (1SW – one sea-winter, 2SW – two sea-winter and PS – previous spawner) of Atlantic salmon (*Salmo salar*) caught at West Greenland, 1969-2013.

	Whole weight (kg)									Fork length (cm)					
	Sea age & origin									Sea age & origin					
	1SW NA	E	2SW NA	E	PS NA	E	All sea ages NA	E	TOTAL	1SW NA	E	2SW NA	E	PS NA	E
1969	3.12	3.76	5.48	5.80	-	5.13	3.25	3.86	3.58	65.0	68.7	77.0	80.3	-	75.3
1970	2.85	3.46	5.65	5.50	4.85	3.80	3.06	3.53	3.28	64.7	68.6	81.5	82.0	78.0	75.0
1971	2.65	3.38	4.30	-	-	-	2.68	3.38	3.14	62.8	67.7	72.0	-	-	-
1972	2.96	3.46	5.85	6.13	2.65	4.00	3.25	3.55	3.44	64.2	67.9	80.7	82.4	61.5	69.0
1973	3.28	4.54	9.47	10.00	-	-	3.83	4.66	4.18	64.5	70.4	88.0	96.0	61.5	-
1974	3.12	3.81	7.06	8.06	3.42	-	3.22	3.86	3.58	64.1	68.1	82.8	87.4	66.0	-
1975	2.58	3.42	6.12	6.23	2.60	4.80	2.65	3.48	3.12	61.7	67.5	80.6	82.2	66.0	75.0
1976	2.55	3.21	6.16	7.20	3.55	3.57	2.75	3.24	3.04	61.3	65.9	80.7	87.5	72.0	70.7
1977	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	2.96	3.50	7.00	7.90	2.45	6.60	3.04	3.53	3.35	63.7	67.3	83.6	-	60.8	85.0
1979	2.98	3.50	7.06	7.60	3.92	6.33	3.12	3.56	3.34	63.4	66.7	81.6	85.3	61.9	82.0
1980	2.98	3.33	6.82	6.73	3.55	3.90	3.07	3.38	3.22	64.0	66.3	82.9	83.0	67.0	70.9
1981	2.77	3.48	6.93	7.42	4.12	3.65	2.89	3.58	3.17	62.3	66.7	82.8	84.5	72.5	-
1982	2.79	3.21	5.59	5.59	3.96	5.66	2.92	3.43	3.11	62.7	66.2	78.4	77.8	71.4	80.9
1983	2.54	3.01	5.79	5.86	3.37	3.55	3.02	3.14	3.10	61.5	65.4	81.1	81.5	68.2	70.5
1984	2.64	2.84	5.84	5.77	3.62	5.78	3.20	3.03	3.11	62.3	63.9	80.7	80.0	69.8	79.5
1985	2.50	2.89	5.42	5.45	5.20	4.97	2.72	3.01	2.87	61.2	64.3	78.9	78.6	79.1	77.0
1986	2.75	3.13	6.44	6.08	3.32	4.37	2.89	3.19	3.03	62.8	65.1	80.7	79.8	66.5	73.4
1987	3.00	3.20	6.36	5.96	4.69	4.70	3.10	3.26	3.16	64.2	65.6	81.2	79.6	74.8	74.8
1988	2.83	3.36	6.77	6.78	4.75	4.64	2.93	3.41	3.18	63.0	66.6	82.1	82.4	74.7	73.8
1989	2.56	2.86	5.87	5.77	4.23	5.83	2.77	2.99	2.87	62.3	64.5	80.8	81.0	73.8	82.2
1990	2.53	2.61	6.47	5.78	3.90	5.09	2.67	2.72	2.69	62.3	62.7	83.4	81.1	72.6	78.6
1991	2.42	2.54	5.82	6.23	5.15	5.09	2.57	2.79	2.65	61.6	62.7	80.6	82.2	81.7	80.0
1992	2.54	2.66	6.49	6.01	4.09	5.28	2.86	2.74	2.81	62.3	63.2	83.4	81.1	77.4	82.7
1995	2.37	2.67	6.09	5.88	3.71	4.98	2.45	2.75	2.56	61.0	63.2	81.3	81.0	70.9	81.3
1996	2.63	2.86	6.50	6.30	4.98	5.44	2.83	2.90	2.88	62.8	64.0	81.4	81.1	77.1	79.4
1997	2.57	2.82	7.95	6.11	4.82	6.90	2.63	2.84	2.71	62.3	63.6	85.7	84.0	79.4	87.0
1998	2.72	2.83	6.44	-	3.28	4.77	2.76	2.84	2.78	62.0	62.7	84.0	-	66.3	76.0
1999	3.02	3.03	7.59	-	4.20	-	3.09	3.03	3.08	63.8	63.5	86.6	-	70.9	-
2000	2.47	2.81	-	-	2.58	-	2.47	2.81	2.57	60.7	63.2	-	-	64.7	-
2001	2.89	3.03	6.76	5.96	4.41	4.06	2.95	3.09	3.00	63.1	63.7	81.7	79.1	75.3	72.1
2002	2.84	2.92	7.12	-	5.00	-	2.89	2.92	2.90	62.6	62.1	83.0	-	75.8	-
2003	2.94	3.08	8.82	5.58	4.04	-	3.02	3.10	3.04	63.0	64.4	86.1	78.3	71.4	-
2004	3.11	2.95	7.33	5.22	4.71	6.48	3.17	3.22	3.18	64.7	65.0	86.2	76.4	77.6	88.0
2005	3.19	3.33	7.05	4.19	4.31	2.89	3.31	3.33	3.31	65.9	66.4	83.3	75.5	73.7	62.3
2006	3.10	3.25	9.72	-	5.05	3.67	3.25	3.26	3.24	65.3	65.3	90.0	-	76.8	69.5
2007	2.89	2.87	6.19	6.47	4.94	3.57	2.98	2.99	2.98	63.5	63.3	80.9	80.6	76.7	71.3
2008	3.04	3.03	6.35	7.47	3.82	3.39	3.08	3.07	3.08	64.6	63.9	80.1	85.5	71.1	73.0
2009	3.28	3.40	7.59	6.54	5.25	4.28	3.48	3.67	3.50	64.9	65.5	84.6	81.7	75.9	73.5
2010	3.44	3.24	6.40	5.45	4.17	3.92	3.47	3.28	3.42	66.7	65.2	80.0	75.0	72.4	70.0
2011	3.30	3.18	5.69	4.94	4.46	5.11	3.39	3.49	3.40	65.8	64.7	78.6	75.0	73.7	76.3
2012	3.34	3.38	6.00	4.51	4.65	3.65	3.44	3.40	3.44	65.4	64.9	75.9	70.4	72.8	68.9
2013	3.33	3.16	6.43	4.51	3.64	5.38	3.39	3.20	3.35	66.2	64.6	81.0	72.8	69.9	73.6

Table 7. Mean fork lengths (cm) and whole weight (kg) by sea age (1SW – one sea-winter and 2SW – two sea-winter), continent of origin, and Northwest Atlantic Fisheries Organization (NAFO) division for Atlantic salmon (*Salmo salar*) caught at West Greenland in 2013 with corresponding standard deviation (SD). Table does not include salmon of unknown age (n=15), origin (n=7) or fork length (n=1).

NAFO Div.	1 SW		2 SW		Previous spawners		All sea ages			
	Fork length (cm) (S.D.)	Whole weight (kg) (S.D.)	Fork length (cm) (S.D.)	Whole weight (kg) (S.D.)	Fork length (cm) (S.D.)	Whole weight (kg) (S.D.)	Fork length (cm) (S.D.)	No.	Whole weight (kg) (S.D.)	No.
North American and European										
1B	65.6 (3.1)	3.20 (0.56)	80.3 (8.2)	6.31 (2.18)	70.3 (7.4)	3.66 (1.24)	66.0 (4.0)	677	3.29 (0.75)	677
1C	66.3 (3.2)	3.45 (0.60)	68.2 (6.0)	3.28 (0.40)	68.0 (7.5)	3.53 (1.56)	66.4 (3.4)	285	3.45 (0.62)	285
1F	66.1 (3.7)	3.32 (0.68)	82.0 (10.8)	6.64 (2.57)	73.6 (8.3)	5.38 (2.75)	66.6 (4.9)	171	3.44 (1.00)	171
All Areas	65.9 (3.2)	3.30 (0.59)	78.7 (9.6)	5.90 (2.36)	70.1 (7.3)	3.74 (1.38)	66.2 (4.0)	1133	3.35 (0.77)	1133
North American										
1B	65.9 (3.0)	3.25 (0.57)	80.9 (8.8)	6.57 (2.25)	70.3 (7.4)	3.66 (1.24)	66.3 (4.0)	564	3.32 (0.77)	564
1C	66.6 (3.2)	3.46 (0.59)	74.3 -	3.29 -	68.0 (7.5)	3.53 (1.56)	66.7 (3.4)	235	3.46 (0.62)	235
1F	66.8 (3.3)	3.41 (0.66)	82.9 (12.3)	6.94 (2.86)	- -	- -	67.3 (4.7)	126	3.53 (1.00)	126
All Areas	66.2 (3.2)	3.33 (0.60)	81.0 (9.4)	6.43 (2.44)	69.9 (7.3)	3.64 (1.27)	66.5 (4.0)	925	3.39 (0.78)	925
European										
1B	64.6 (3.1)	3.12 (0.50)	77.6 (6.4)	5.29 (2.16)	- -	- -	64.8 (3.6)	113	3.16 (0.60)	113
1C	65.0 (2.9)	3.36 (0.58)	65.2 (3.9)	3.27 (0.56)	- -	- -	65.0 (2.9)	50	3.36 (0.57)	50
1F	64.0 (3.9)	3.03 (0.63)	78.7 -	5.44 -	73.6 (8.3)	5.38 (2.75)	64.7 (4.9)	45	3.19 (0.95)	45
All Areas	64.6 (3.3)	3.16 (0.56)	72.8 (7.9)	4.51 (1.59)	73.6 (8.3)	5.38 (2.75)	64.8 (3.8)	208	3.20 (0.69)	208

Table 8. The smolt age (river age) composition (%) of Atlantic salmon (*Salmo salar*) by continent of origin (NA - North American and E – European) and Northwest Atlantic Fisheries Organization (NAFO) division caught in 2013 at West Greenland. Table does not include salmon of unknown age (n=41) or origin (n=7).

NAFO Division	Origin	River age (%)						Total No.
		1	2	3	4	5	6	
1A	NA	0.0	33.8	35.8	20.1	9.4	0.9	562
	E	5.4	71.2	21.6	0.9	0.9	0.0	111
		0.9	40.0	33.4	16.9	8.0	0.7	673
1D	NA	0.5	28.2	41.8	21.4	8.2	0.0	220
	E	2.1	57.4	34.0	6.4	0.0	0.0	47
		0.7	33.3	40.4	18.7	6.7	0.0	267
1F	NA	0.0	35.2	36.0	23.2	5.6	0.0	125
	E	4.7	72.1	20.9	2.3	0.0	0.0	43
		1.2	44.6	32.1	17.9	4.2	0.0	168
All Areas	NA	0.1	32.6	37.3	20.8	8.6	0.6	907
	E	4.5	68.2	24.4	2.5	0.5	0.0	201
	NA+E	0.9	39.1	34.9	17.5	7.1	0.5	1108

Table 9. River age distribution (%) for North American and European origin Atlantic salmon (*Salmo salar*) caught at West Greenland, 1968-2013. Not all rows add to 1.0 due to rounding errors.

YEAR	1	2	3	4	5	6	7	8
North American								
1968	0.3	19.6	40.4	21.3	16.2	2.2	0	0
1969	0	27.1	45.8	19.6	6.5	0.9	0	0
1970	0	58.1	25.6	11.6	2.3	2.3	0	0
1971	1.2	32.9	36.5	16.5	9.4	3.5	0	0
1972	0.8	31.9	51.4	10.6	3.9	1.2	0.4	0
1973	2.0	40.8	34.7	18.4	2.0	2.0	0	0
1974	0.9	36.0	36.6	12.0	11.7	2.6	0.3	0
1975	0.4	17.3	47.6	24.4	6.2	4.0	0	0
1976	0.7	42.6	30.6	14.6	10.9	0.4	0.4	0
1978	2.7	31.9	43.0	13.6	6.0	2.0	0.9	0
1979	4.2	39.9	40.6	11.3	2.8	1.1	0.1	0
1980	5.9	36.3	32.9	16.3	7.9	0.7	0.1	0
1981	3.5	31.6	37.5	19.0	6.6	1.6	0.2	0
1982	1.4	37.7	38.3	15.9	5.8	0.7	0	0.2
1983	3.1	47.0	32.6	12.7	3.7	0.8	0.1	0
1984	4.8	51.7	28.9	9.0	4.6	0.9	0.2	0
1985	5.1	41.0	35.7	12.1	4.9	1.1	0.1	0
1986	2.0	39.9	33.4	20.0	4.0	0.7	0	0
1987	3.9	41.4	31.8	16.7	5.8	0.4	0	0
1988	5.2	31.3	30.8	20.9	10.7	1.0	0.1	0
1989	7.9	39.0	30.1	15.9	5.9	1.3	0	0
1990	8.8	45.3	30.7	12.1	2.4	0.5	0.1	0
1991	5.2	33.6	43.5	12.8	3.9	0.8	0.3	0
1992	6.7	36.7	34.1	19.1	3.2	0.3	0	0
1995	2.4	19.0	45.4	22.6	8.8	1.8	0.1	0
1996	1.7	18.7	46.0	23.8	8.8	0.8	0.1	0
1997	1.3	16.4	48.4	17.6	15.1	1.3	0	0
1998	4.0	35.1	37.0	16.5	6.1	1.1	0.1	0
1999	2.7	23.5	50.6	20.3	2.9	0.0	0.0	0
2000	3.2	26.6	38.6	23.4	7.6	0.6	0	0
2001	1.9	15.2	39.4	32.0	10.8	0.7	0	0
2002	1.5	27.4	46.5	14.2	9.5	0.9	0	0
2003	2.6	28.8	38.9	21.0	7.6	1.1	0	0
2004	1.9	19.1	51.9	22.9	3.7	0.5	0	0
2005	2.7	21.4	36.3	30.5	8.5	0.5	0	0
2006	0.6	13.9	44.6	27.6	12.3	1.0	0	0
2007	1.6	27.7	34.5	26.2	9.2	0.9	0	0
2008	0.9	25.1	51.9	16.8	4.7	0.6	0	0
2009	2.6	30.7	47.3	15.4	3.7	0.4	0	0
2010	1.6	21.7	47.9	21.7	6.3	0.8	0	0
2011	1.0	35.9	45.9	14.4	2.8	0.0	0	0
2012	0.3	29.8	39.4	23.3	6.5	0.7	0	0
2013	0.1	32.6	37.3	20.8	8.6	0.6	0	0
10 yr mean								
(2004-2013)	1.3	25.8	43.7	22.0	6.6	0.6	0.0	0.0
Overall Mean	2.6	31.6	39.6	18.3	6.8	1.1	0.1	0.0

Table 9 continued.

YEAR	1	2	3	4	5	6	7	8
European								
1968	21.6	60.3	15.2	2.7	0.3	0	0	0
1969	0	83.8	16.2	0	0	0	0	0
1970	0	90.4	9.6	0	0	0	0	0
1971	9.3	66.5	19.9	3.1	1.2	0	0	0
1972	11.0	71.2	16.7	1.0	0.1	0	0	0
1973	26.0	58.0	14.0	2.0	0	0	0	0
1974	22.9	68.2	8.5	0.4	0	0	0	0
1975	26.0	53.4	18.2	2.5	0	0	0	0
1976	23.5	67.2	8.4	0.6	0.3	0	0	0
1978	26.2	65.4	8.2	0.2	0	0	0	0
1979	23.6	64.8	11.0	0.6	0	0	0	0
1980	25.8	56.9	14.7	2.5	0.2	0	0	0
1981	15.4	67.3	15.7	1.6	0	0	0	0
1982	15.6	56.1	23.5	4.2	0.7	0	0	0
1983	34.7	50.2	12.3	2.4	0.3	0.1	0.1	0
1984	22.7	56.9	15.2	4.2	0.9	0.2	0	0
1985	20.2	61.6	14.9	2.7	0.6	0	0	0
1986	19.5	62.5	15.1	2.7	0.2	0	0	0
1987	19.2	62.5	14.8	3.3	0.3	0	0	0
1988	18.4	61.6	17.3	2.3	0.5	0	0	0
1989	18.0	61.7	17.4	2.7	0.3	0	0	0
1990	15.9	56.3	23.0	4.4	0.2	0.2	0	0
1991	20.9	47.4	26.3	4.2	1.2	0	0	0
1992	11.8	38.2	42.8	6.5	0.6	0	0	0
1995	14.8	67.3	17.2	0.6	0	0	0	0
1996	15.8	71.1	12.2	0.9	0	0	0	0
1997	4.1	58.1	37.8	0	0	0	0	0
1998	28.6	60.0	7.6	2.9	0.0	1.0	0	0
1999	27.7	65.1	7.2	0	0	0	0	0
2000	36.5	46.7	13.1	2.9	0.7	0	0	0
2001	16.0	51.2	27.3	4.9	0.7	0	0	0
2002	9.4	62.9	20.1	7.6	0	0	0	0
2003	16.2	58.0	22.1	3.0	0.8	0	0	0
2004	18.3	57.7	20.5	3.2	0.2	0	0	0
2005	19.2	60.5	15.0	5.4	0	0	0	0
2006	17.7	54.0	23.6	3.7	0.9	0	0	0
2007	7.0	48.5	33.0	10.5	1.0	0	0	0
2008	7.0	72.8	19.3	0.8	0	0	0	0
2009	14.3	59.5	23.8	2.4	0	0	0	0
2010	11.3	57.1	27.3	3.4	0.8	0	0	0
2011	19.0	51.7	27.6	1.7	0	0	0	0
2012	9.3	63.0	24.0	3.7	0	0	0	0
2013	4.5	68.2	24.4	2.5	0.5	0	0	0
10 yr mean								
(2004-2013)	12.8	59.3	23.8	3.7	0.3	0.0	0.0	0.0
Overall Mean	17.3	61.0	18.7	2.7	0.3	0.0	0.0	0.0

Table 10. The sea-age (1SW – one sea-winter and 2SW – two sea-winter) composition of Atlantic salmon (*Salmo salar*) by continent of origin (NA = North American and E = European) and Northwest Atlantic Fisheries Organization (NAFO) division caught at West Greenland in 2013. Table does not include salmon with unknown age (n=15) or origin (n=7). Not all rows add to 100 due to rounding errors.

NAFO	Origin	Sea-age composition (%)			Total No.
		1SW	2SW	Previous Spawners	
1B	NA	93.6	1.4	5.0	564
	E	98.2	1.8	0.0	113
		94.4	1.5	4.1	677
1C	NA	97.0	0.4	2.5	236
	E	96.0	4.0	0.0	50
		96.9	1.0	2.1	286
1F	NA	96.8	3.2	0.0	126
	E	93.3	2.2	4.4	45
		95.9	2.9	1.2	171
All areas	NA	94.9	1.4	3.7	926
	E	96.6	2.4	1.0	208
	NA+E	95.2	1.6	3.2	1134

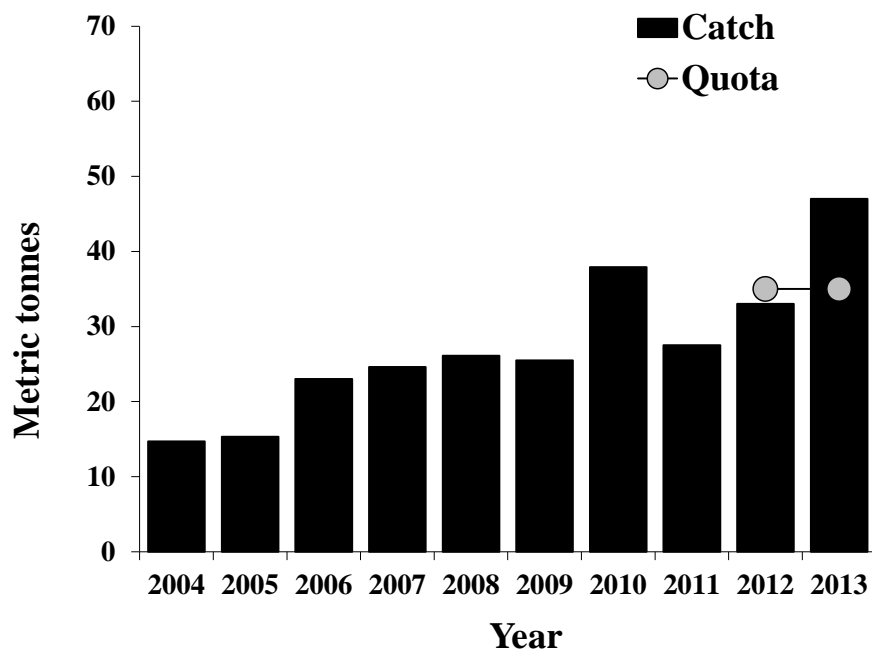
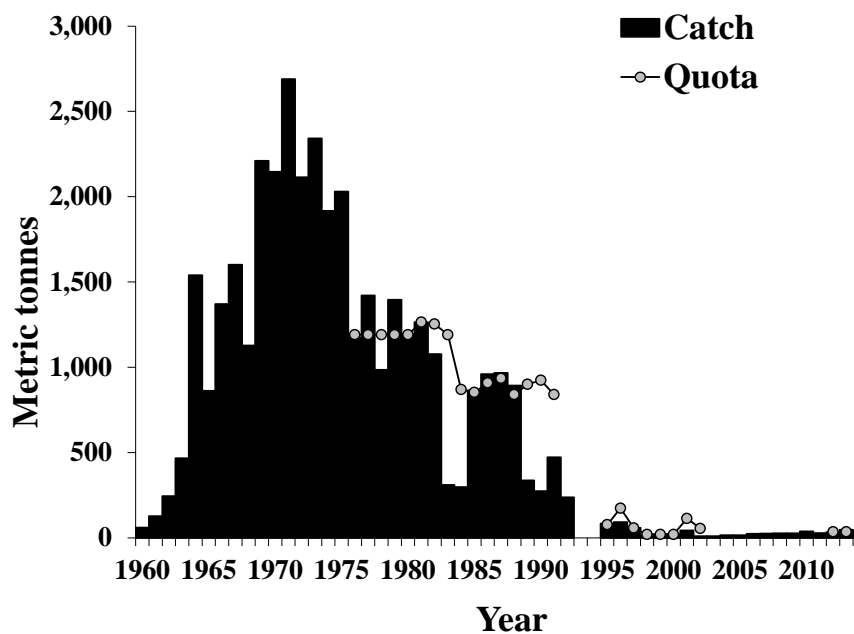


Figure 1. Reported landings and quota for the Atlantic salmon (*Salmo salar*) fishery in Greenlandic home waters for 1960-2013 (top) and 2004-2013 (bottom). 2013 reported landings were 47 metric tons (t). A quota of 35 t was set for factory landings only in 2012-2013, but non-factory landings were unrestricted by this quota.

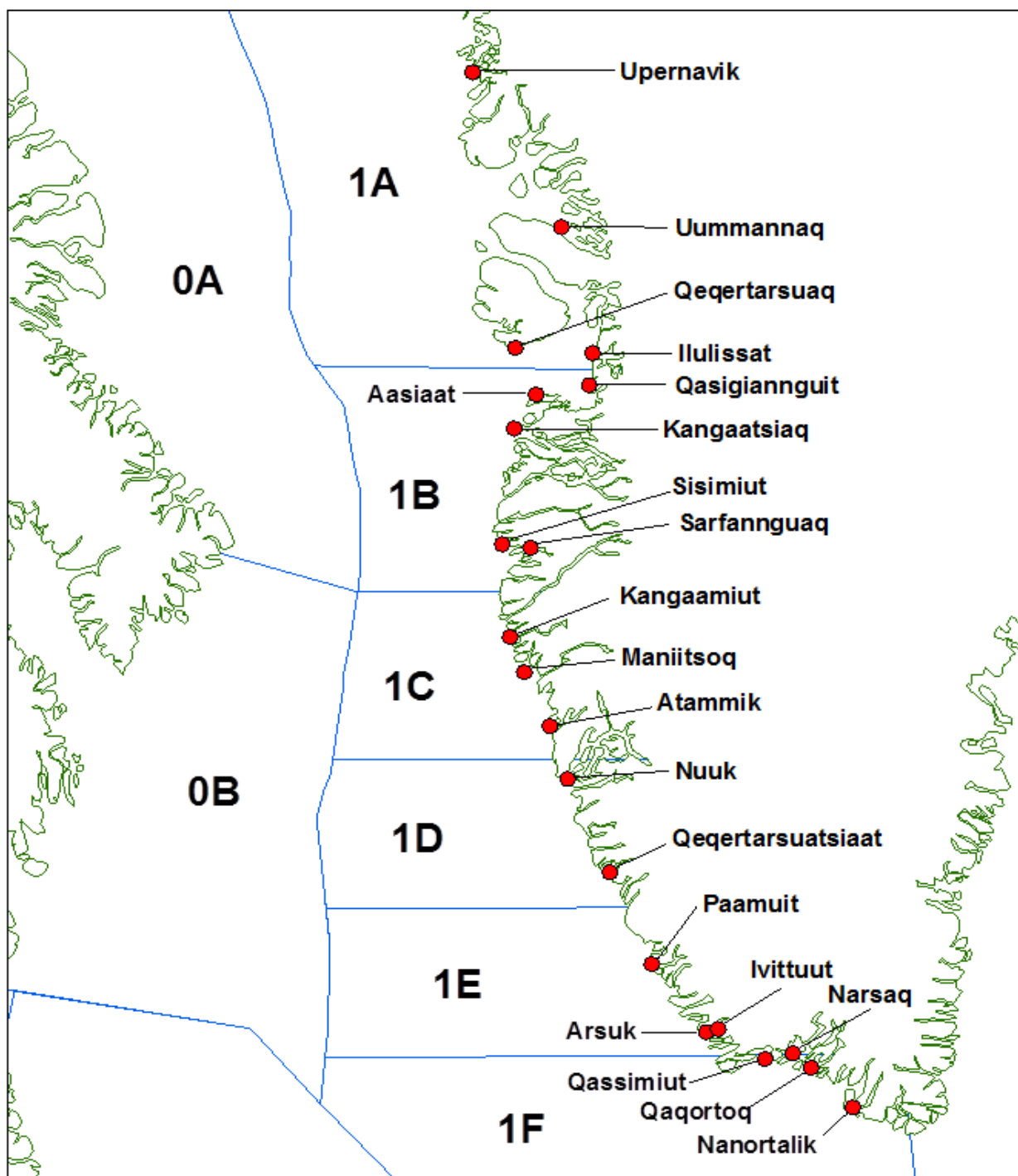


Figure 2. Map of Southwest Greenland showing communities to which Atlantic salmon (*Salmo salar*) have historically been landed. Northwest Atlantic Fisheries Organization (NAFO) divisions (1A-1F) are also shown.

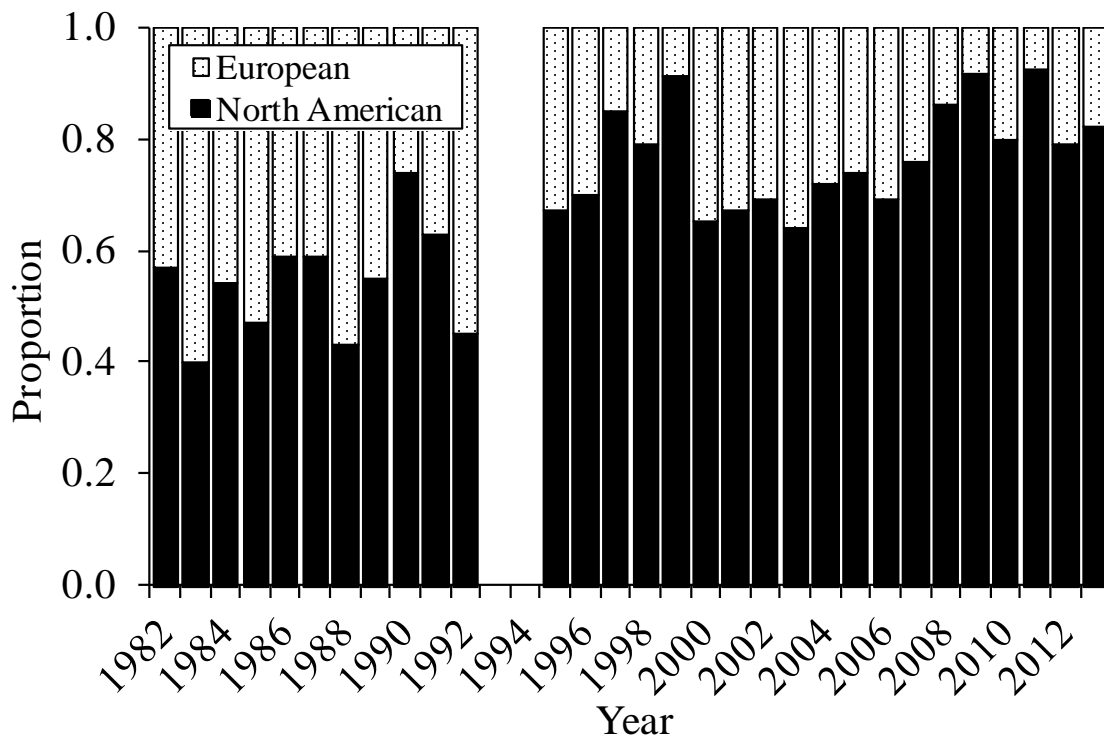


Figure 3. The weighted proportions of North American and European Atlantic salmon (*Salmo salar*) caught at West Greenland from 1982-2013. Proportions were weighted by the estimated numbers of salmon, by origin, for each division according to the adjusted landings.

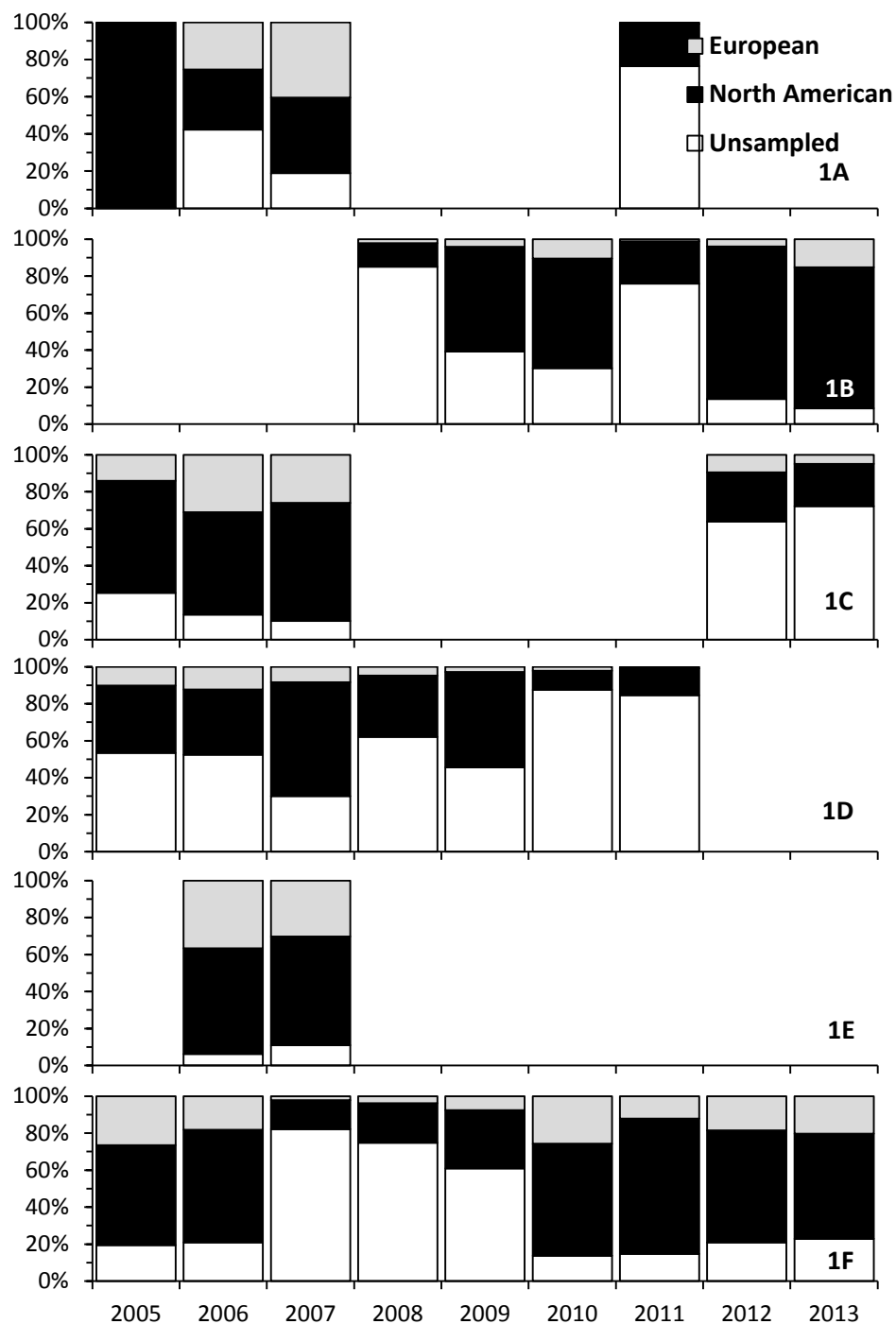


Figure 4. Proportions of unsampled adjusted landings of North American origin and European origin Atlantic salmon (*Salmo salar*) by Northwest Atlantic Fisheries Organization (NAFO) divisions sampled at West Greenland from 2005-2013. Year-division combinations with data identify when and where sampling occurred. Division 1A 2005 value is from one sample.

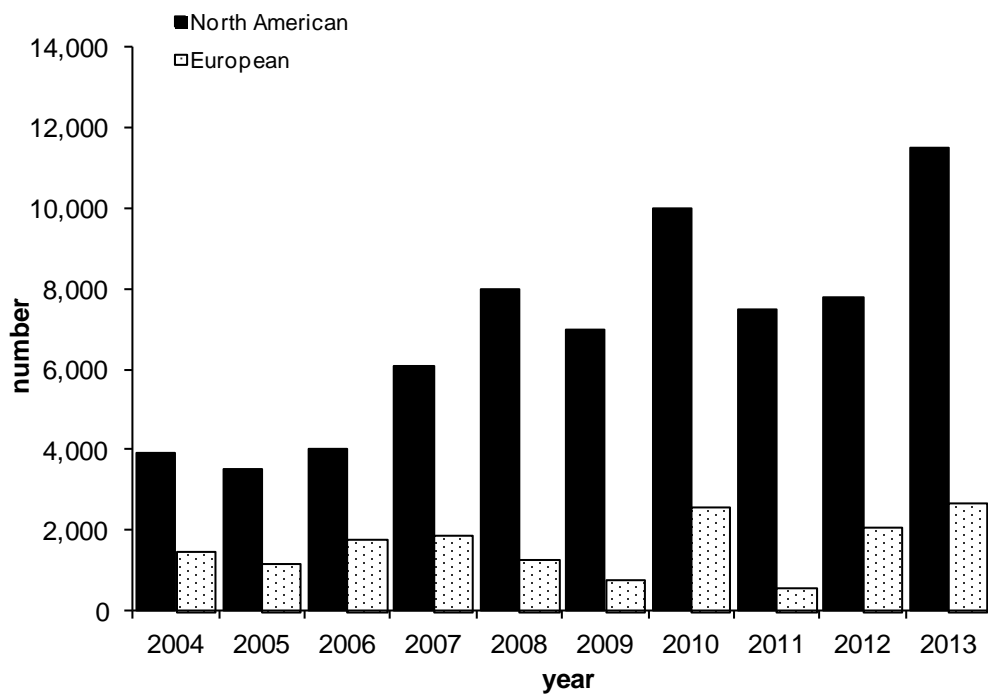
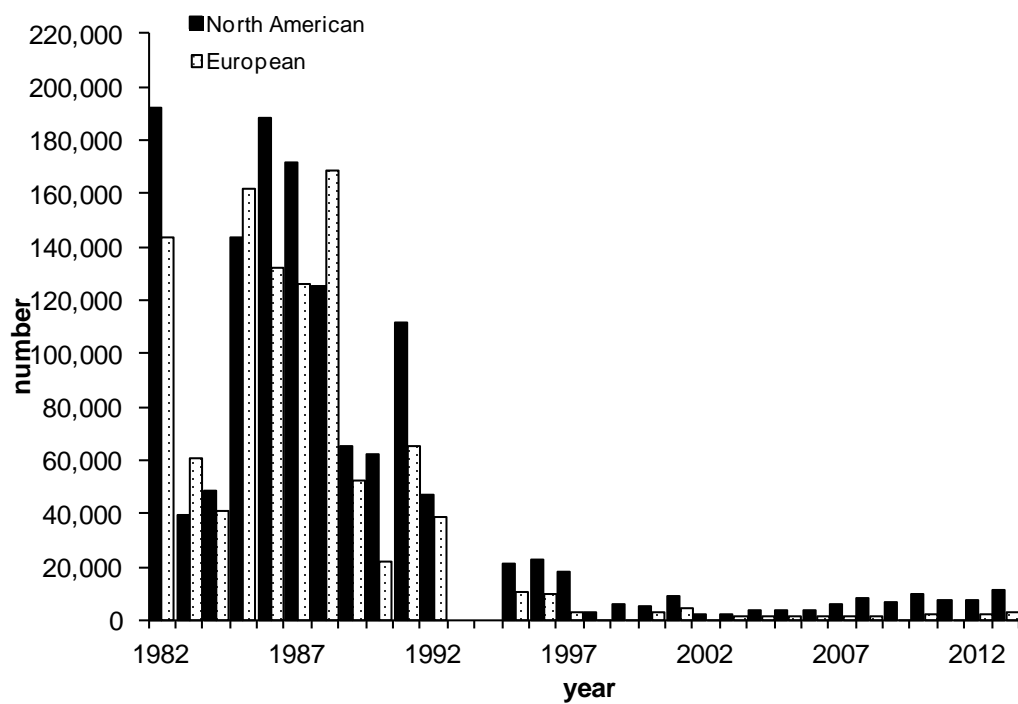


Figure 5. The weighted numbers of North American and European Atlantic salmon (*Salmo salar*) caught at West Greenland from 1982-2013 (top) and 2004-2013 (bottom). Numbers are rounded to the nearest hundred fish. In 2013, it is estimated that approximately 11,500 and 2700 North American and European origin fish were harvested, respectively.

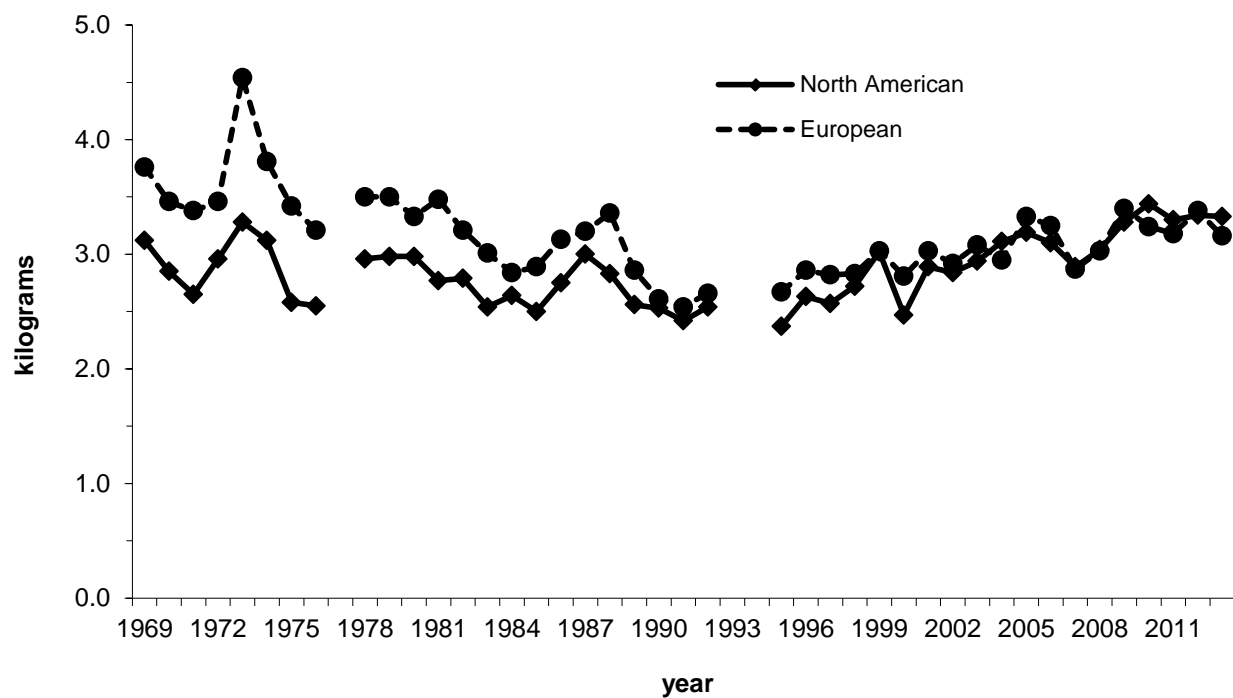


Figure 6. Mean uncorrected whole weight (kg) of European and North American one sea-winter Atlantic salmon (*Salmo salar*) sampled in West Greenland from 1969-2013.

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